
Section 22
Planning Assistance To States Program

Cohasset Water Quality Study
Cohasset, Massachusetts

February 1999



**US Army Corps
of Engineers**

New England District

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE February 1999		3. REPORT TYPE AND DATES COVERED Planning Assistance To States Program
4. TITLE AND SUBTITLE Cohasset Water Quality Study Cohasset, Massachusetts			5. FUNDING NUMBERS	
6. AUTHOR(S) U.S. Army Corps of Engineers New England District				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers New England District 696 Virginia Road Concord, MA 01742			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers New England District 696 Virginia Road Concord, MA 01742			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION AVAILABILITY STATEMENT Approved for public release, distribution unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) <p>Concerned about potential threats to the quality of their water supply system, the town of Cohasset requested the Corps to perform a limited watershed study under the authority of the Planning Assistance to States Program. Sediment and water samples were collected to check for possible contamination from the former Hingham Annex, Wompatuck State Park hazardous waste site, Cohasset Heights Ltd. landfill, and residential areas draining into the Aaron River and Lily Pond. Results mostly showed levels of contamination within the expected range of background conditions even during storm runoff; however, some elevated levels of lead, nitrate, and fecal coliforms were found. These do not appear to be signs of serious problems, but it would be prudent to follow up on them with additional sampling. Unless this follow up sampling or other data collected by the Town shows stronger evidence of contamination, future monitoring by the town should concentrate on the more common contaminants such as coliform bacteria nitrogen, and phosphorus rather than the expense of extensive monitoring for the rarer contaminants such as metals and toxic organic chemicals.</p>				
14. SUBJECT TERMS Cohasset, water quality, water supply, Aaron River, Lily Pond, James River			15. NUMBER OF PAGES 26	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT	

Cohasset Water Quality Study

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February 1999

COHASSET WATER QUALITY STUDY

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COHASSET WATER QUALITY STUDY

1. EXECUTIVE SUMMARY

Concerned about potential threats to the quality of their water supply system, the town of Cohasset requested the Corps to perform a limited watershed study under the authority of the Planning Assistance to States Program. Sediment and water samples were collected to check for possible contamination from the former Hingham Annex, Wompatuck State Park hazardous waste site, Cohasset Heights Ltd. landfill, and residential areas draining into the Aaron River and Lily Pond. Results mostly showed levels of contamination within the expected range of background conditions even during storm runoff; however, some elevated levels of lead, nitrate, and fecal coliforms were found. These do not appear to be signs of serious problems, but it would be prudent to follow up on them with additional sampling. Unless this follow up sampling or other data collected by the Town shows stronger evidence of contamination, future monitoring by the town should concentrate on the more common contaminants such as coliform bacteria nitrogen, and phosphorus rather than the expense of extensive monitoring for the rarer contaminants such as metals and toxic organic chemicals.

2. INTRODUCTION

The Aaron River, Lily Pond, and James Brook watersheds are the primary sources of public drinking water for about 90 percent of the 7,500 residents of Cohasset. These watersheds total 9.21 square miles in Cohasset, Hingham, Norwell, and Scituate. Only about 40 percent of the watersheds lie within the boundaries of Cohasset. Figure 1 shows the location of the study area.

Lily Pond and its tributaries are class A waters by Massachusetts water quality regulations. Class A waters are designated as a source of public water supply. These protected waters are further designated as outstanding resource waters under 314 CMR 4.04 (3).

The quality and future viability of drinking water is threatened by several potential sources including uncontrolled nonpoint source pollution, septic systems, leaking underground storage tanks, industrial runoff, existing and closed solid waste landfills, and residential development.

The purpose of this investigation was to determine, on a broad scale, the water quality status of the Aaron River, Lily Pond, and James Brook watersheds. Specifically, the investigation monitored several potential areas of contamination, established baseline water quality conditions for the area, and recommended a water quality monitoring plan to the town.



COHASSET WATER QUALITY STUDY PROJECT STUDY AREA

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Figure 1

3. COHASSET SAMPLING PLAN

a. General. Sampling stations were divided into three categories depending on the types of contamination being checked for, and analyses to be performed: high flow stations, indicator stations, and sediment stations. Most stations were used for more than one purpose. Table 1 gives sampling station names and descriptions, and figures 2 and 3 show their locations.

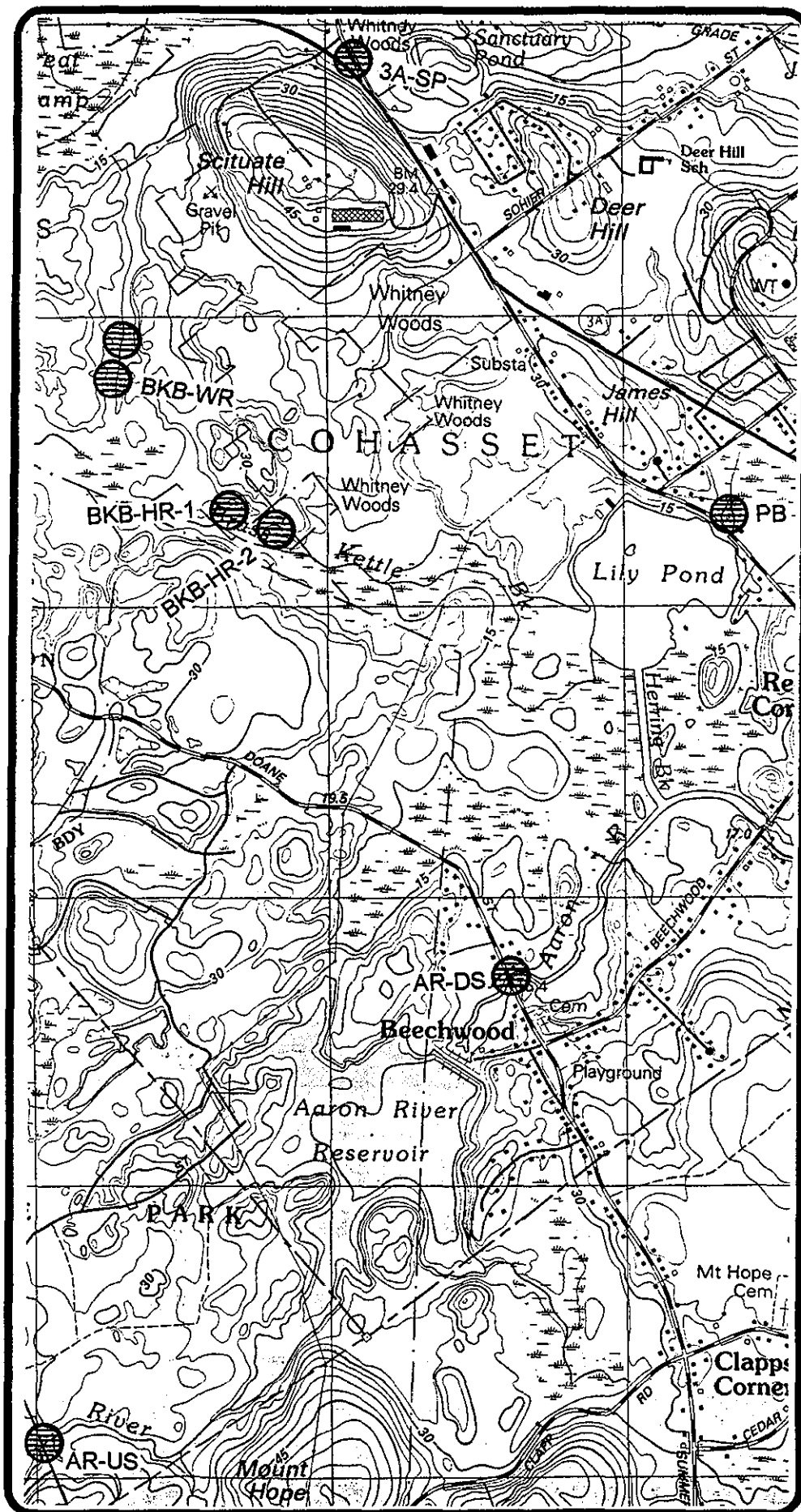
TABLE 1 SAMPLING STATION NAMES AND DESCRIPTIONS	
Station Name	Station Description
PB	Peppermint Brook entering Lily Pond at King St.
AR-DS	Aaron River at Doane St.
3A-SP	Stream between Rt. 3A and Sanctuary Pond
AR-US	Aaron River at Union Street
BKB-BL	Brass Kettle Brook at Boulder Lane
BKB-WR	Brass Kettle Brook at Whitney Road
BKB-HR-1	Brass Kettle Brook upstream of Howes Road
BKB-HR-2	Brass Kettle Brook downstream of Howes Road

b. Station Description.

(1) PB. This station is on Peppermint Brook where it enters Lily Pond at King Street. High flow and sediment samples were collected here.

(2) AR-DS. This station is on the Aaron River at Doane Street in Beechwood, a part of Cohasset. High flow and sediment samples were collected here.

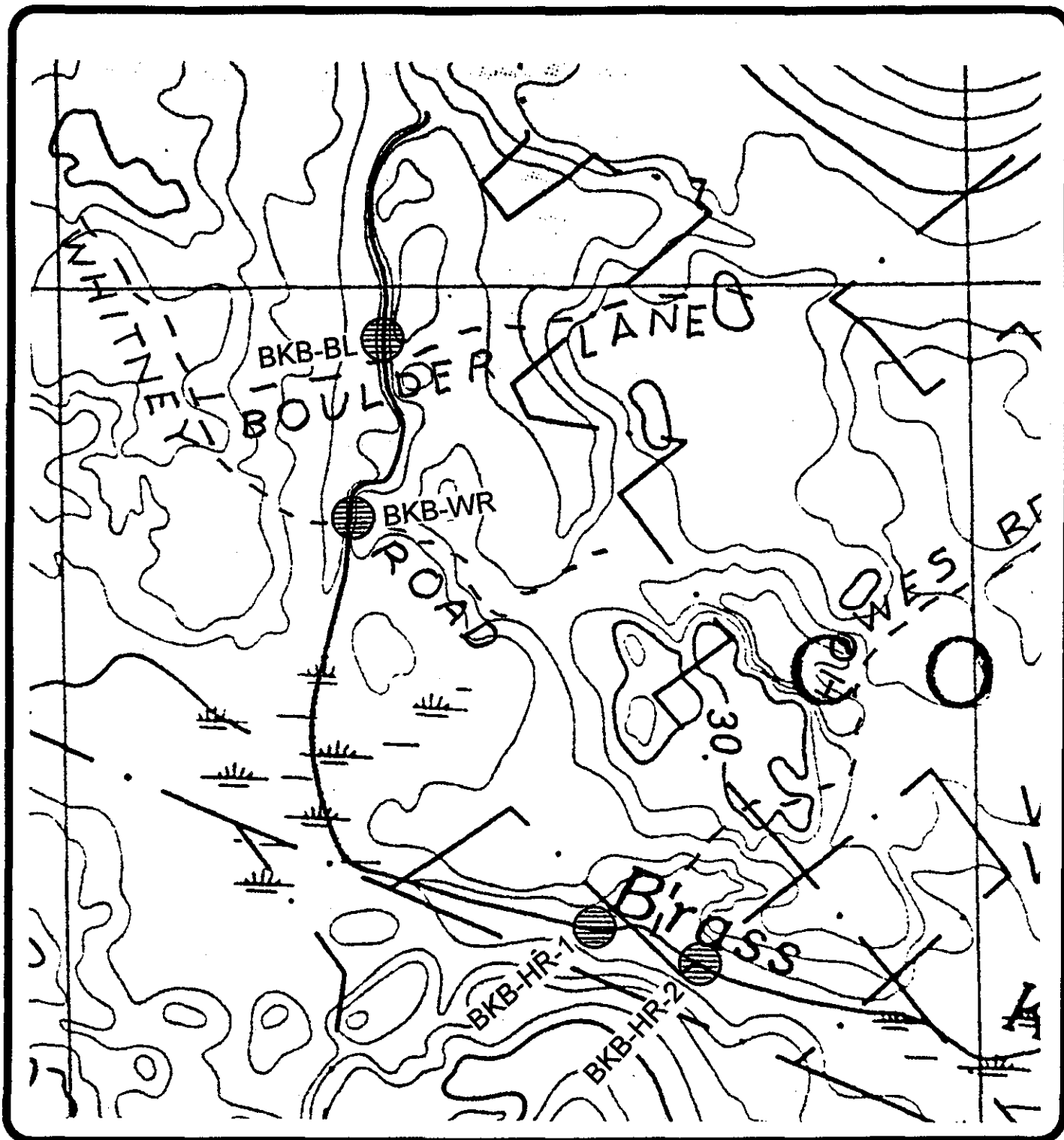
(3) 3A-SP. This station is located northeast of Whitney Hill, between Route 3A and Sanctuary Pond. This station captures flow from a culvert carrying water coming down Scituate Hill and the Cohasset Heights Ltd. landfill, under Route 3A toward Sanctuary Pond and the James Brook watershed, which is the source for the town's two well fields, the Sohler Street and Ellms Meadow well fields. High flow, sediment, and indicator samples were collected at this station.




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● - Cohasset Water Quality Study
Sampling Stations

Figure 2



 - COHASSET WATER QUALITY STUDY
 BRASS KETTLE BROOK SAMPLING STATIONS

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Figure 3

(4) AR-US. This station is on the Aaron River where it crosses Union Street. Samples for high flow and sediment analyses were taken on the northeast side of Union Street.

(5) BKB-BL. The first station on Brass Kettle Brook is at Boulder Lane, a dirt road through the woods that is not shown on the latest (1984) USGS map. High flow and sediment samples were collected here.

(6) BKB-WR. The second station on Brass Kettle Brook is at Whitney Road, a dirt road not shown on the USGS map. It is just downstream from Boulder Lane. High flow and sediment samples were collected here.

(7) BKB-HR-1. This station is on Brass Kettle Brook just upstream of the Howes Road bridge. Sediment data was collected at this station.

(8) BKB-HR-2. This station is on Brass Kettle Brook just downstream of the Howes Road bridge. Sediment data was collected at this station.

c. High-Flow Stations. These stations were used to check for contamination from the Cohasset Heights Ltd. landfill, Wompatuck State Park hazardous waste site, and Hingham Annex. At four locations, 2 along Brass Kettle Brook (BKB-BL and BKB-WR) and 1 each at Sanctuary Pond (3A-SP) and the Aaron River at Union Street (AR-US), water samples were collected on 7 May 1998 after more than 1 inch of rain fell in the previous 24 hours. Samples were analyzed for volatile organic compounds (VOCs), total and filtered metals, temperature, pH, DO, and conductivity.

d. Indicator Stations. Data from these stations were needed to check for signs of nonpoint source contamination such as leaking septic tanks, and therefore needed to be collected during high flow conditions. On 7 May 1998, at Sanctuary Pond (3A-SP), Peppermint Brook (PB) and the Aaron River at Doane Street (AR-DS), samples were collected and analyzed for fecal coliforms, temperature, pH, DO, conductivity, chloride, and nitrate.

e. Sediment Stations. These stations were also used to check for contamination from the Cohasset Heights Ltd. landfill, Wompatuck State Park hazardous waste site, and the Hingham Annex, but the top 6 inches of sediment rather than water was to be collected and samples were taken during dry weather. Sediment samples were collected on 6 June 1997 from stations Sanctuary Pond (3A-SP), Union Street (AR-US), and Brass Kettle Brook (BKB-BL and BKB-WR). Additional sediment samples were collected at stations on Brass Kettle Brook at Howes Road (BKB-HR-1 and BKB-HR-2) on 25 June 1998. All samples were analyzed for semi-volatile organics (SVOCs), RCRA metals and mercury, and percent solids.

4. RESULTS

a. High Flow and Indicator Station Data. Analyses of samples collected during high flow conditions showed some high coliform counts and nitrate concentrations, but overall levels of contamination were not outside the range of probable background conditions. Table 2 summarizes this data. No VOCs and no metals except barium were detected in water samples. Chloride, nitrate, and fecal coliform levels were not necessarily high for storm conditions. Dissolved oxygen levels were high except for parts of Brass Kettle Brook, which are in a wetland area that would be expected to have naturally low DO levels. Levels of pH were low, but not unusually so.

(1) Hydrologic Conditions. As a general rule, contaminant concentrations from nonpoint sources are highest in streams during runoff events, because that is when these materials are washed into waterways. High flow sampling on 7 May 1998 occurred after 1.0 inches of rain were recorded at the Cohasset Water Treatment Plant on 6 May. An additional 0.96 inches of rain were recorded before the sampling took place in the afternoon. Precipitation earlier in the month raised groundwater levels so that good runoff could be expected from this storm, without washing the land clean.

(2) VOCs. No detectable concentrations of VOCs were found at any of the 4 stations. Method detection limits were generally in the range of 1 to 5 ppb, but some were at the level of 10 ppb and 2 were at the 25 ppb level. These detection limits are appropriate for this study. VOCs are by definition volatile, and unless there is a fresh source such as contaminated groundwater, detectable concentrations are not likely to be found.

TABLE 2
HIGH FLOW AND INDICATOR STATION DATA

Station	DO (ppm)	Temp (°C)	pH (SU)	Cond (uS/cm)	Chloride (ppm)	Nitrate (ppm)	Fecal Coliforms (per 100 ml)	Barium (ppm)
AR-US	9.2	13.1	5.7	60	NA	NA	NA ¹	0.01
3A-SP	8.0	13.1	6.4	614	150	0.26	85	0.05
PB	8.4	12.9	6.5	215	47	0.37	290	NA
AR-DS	9.5	16.8	5.78	99	21	<0.10	18	NA
BKB-BL	3.4	14.8	5.8	69	NA	NA	NA	0.01
BKB-WR	5.3	13.4	5.6	66	NA	NA	NA	0.01

NA¹ - Not analyzed

(3) Metals. No harmful levels of metals were found in water. The only metal detected in water was barium, which was found at all stations at levels between 0.01 and 0.05 ppm. Total and dissolved barium levels were equal at all stations, indicating that it was all in the dissolved form. Federal drinking water standard for barium is 2 ppm, and no aquatic life criteria were established because of its low toxicity; consequently, these levels are not a concern. Method detection limits for all metals were less than or equal to federal drinking water standards and, therefore, were appropriate for this study.

(4) Chlorides. Levels of chloride ranged from 21 to 150 ppm, with the highest level at station AR-US, the Aaron River at Union Street. These levels are within the normal range for Eastern Massachusetts. There are no Massachusetts or EPA standards for chloride in drinking water. However, the US Public Health Service Drinking Water Standards of 1962 recommended a limit of 250 ppm. These levels of chloride are well below that recommended standard.

(5) Nitrates. Levels of nitrates ranged from less than 0.10 to 0.37 ppm, with Peppermint Brook at Lily Pond having the highest concentration. These levels would be somewhat high if they represented average dry weather flow conditions, but it is not necessarily an indication of problems to find such levels during storm runoff. Massachusetts's regulations do not have numerical guidelines for nutrients. All that 314 CMR 4.04(5) says is that, "Activities which result in the nonpoint source discharge of nutrients to lakes and ponds shall be provided with all reasonable best management

practices for nonpoint source control.” For comparison, Connecticut Water Quality Standards give a range typical for mesotrophic lakes of 0.2 to 0.6 ppm total nitrogen in spring and summer. A mesotrophic impoundment is moderately enriched with plant nutrients and has moderate biological productivity characterized by occasional nuisance blooms of algae or small areas of nuisance aquatic weeds. Since nitrate typically constitutes the majority of total nitrogen in natural waters, the level measured in Peppermint Brook is in the middle of the range for mesotrophic impoundments, and this was measured during a rainstorm when levels would be expected to be higher. These nitrates may originate in runoff containing lawn fertilizers.

An oligotrophic condition is highly desirable for a water supply, while a eutrophic condition is a definite problem. A mesotrophic impoundment is somewhere in between. This single set of samples collected after a rainstorm does not define Lily Pond’s trophic condition. If all nitrate levels in these samples were very low, one could be fairly confident there was not a problem; if any were extremely high, there would be a problem. Findings in this range indicate there probably isn’t a problem, but further investigation would be prudent.

(6) Fecal Coliforms. The standard for fecal coliform bacteria in a Massachusetts class A water is that they, “Shall not exceed an arithmetic mean of 20 organisms per 100 ml in any representative set of samples, nor shall 10 percent of the samples exceed 100 organisms per 100 ml.” Because bacteria counts and other pollutants rise after rain, samples collected only following a rainstorm do not constitute a “representative set of samples.” In any case, three samples are not enough to calculate a statistically significant mean or 10 percent exceedence. The highest fecal coliform count was at station PB where Peppermint Brook enters Lily Pond. By itself, the 290 per 100 ml measured at that station does not violate class A standards. While a count of 290 per 100 ml during wet weather is not a definite sign of a problem, there is the potential that a problem exists. Additional sampling during storms is required to reduce the uncertainty.

(7) pH. At all stations, pH was at or below the recommended minimum of 6.5 for aquatic life; however, measured levels down to 5.6 are not unusual in New England where acid rain falls on soils of granitic origin which have poor buffering capacity. In drinking water supplies, pH is a corrosion concern in the distribution system. If lead or copper levels in the distribution system are exceeding criteria, then treatment to raise the pH in the distribution system may be necessary. As New England waters are typically poorly buffered, it is rarely difficult to adjust the pH. The pH levels observed in this study would not preclude the use of the water as a source for public supply, but may require adjustment before final distribution.

b. Sediment Data - SVOCs. These compounds were in very low concentrations typical of background conditions. All SVOCs in detectable levels were below quantifiable concentrations. Detected SVOCs were all either products of incomplete combustion or plasticizers, and in both cases are ubiquitous in the environment. In

addition, all detected SVOCs are compounds which strongly bind to sediments, particularly organic sediments. Table 3 lists detected SVOCs by category.

All SVOCs in detectable concentrations were reported with the prefix "J" in front of them. This is a standard symbol meaning the analyte was found at a concentration less than the lower reporting limit but greater than method detection limit. In other words, the analytical procedure detected the compound so it was at least at the method detection limit, but the concentration was too low to measure. Therefore, the concentration is somewhere between the method detection and method reporting limits. The value reported in the table is the method reporting limit, and is an estimate; the actual value is probably less.

Most of the SVOCs found in detectable concentrations are products of incomplete combustion, although many of them can be produced by other means including synthesis by plants and algae. Because these compounds come out of forest fires, incinerators, and automobile exhaust, they are found everywhere including remote areas of the world. The majority of these detected partial combustion products were polynuclear aromatic hydrocarbons (PAHs), and these are the most commonly detected SVOCs in sediments and soils.

All other detected SVOCs in this study were plasticizers, which are compounds added to plastics to control their properties, typically to make them more flexible. Plasticizers tend to leach out and, because of the ubiquitousness of plastics in the environment, they tend to be found everywhere. Bis(2-ethylhexyl)phthalate and diethylphthalate are also notorious laboratory contaminants, often showing up in laboratory blanks.

There are no standards for contaminants in sediments and soils as there are for contaminants in water. It is highly unlikely that good sediment quality criteria can be developed because sediments are chemically and physically so variable and complex. In the absence of such criteria, contaminant concentrations in sediments were compared to levels in the Massachusetts Contingency Plan (MCP) and levels found at other NAE reservoir projects. These comparisons are very useful for screening the data.

(1) Massachusetts Contingency Plan. The MCP is the set of regulations dealing with the cleanup of hazardous materials contamination in the ground. It includes groundwater classification and soil standards for 110 contaminants including heavy metals, pesticides, PCBs, dioxins, and volatile and semi volatile organic compounds.

All groundwater, which is a potential source of discharge to surface water, is classified as GW-3. Groundwater which is in a current or potential drinking water source area may also be classified GW-1, and groundwater which is close to buildings and has a potential to be contaminated may additionally be classified as GW-2. It is possible for the groundwater at one site to be classified GW-3, GW-2, and GW-1. Classification of the

TABLE 3
DECTABLE SVOCs IN SEDIMENT
(ppm)

	3A-SP	AR-US	BKB-BL	BKB-WR	BKB-HR-1, -2	MCP ¹	Clean NAE Projects ²
Incomplete Combustion Products							
PAHs							
Acenaphthene	J 0.057³	ND ⁴	ND	ND	ND	20	<0.01 - J 0.079
Acenaphthylene	J 0.16	J 0.099	ND	J 0.047	ND	100	<0.014 - J 0.18
Anthracene	J 0.15	ND	ND	ND	ND	1,000	<0.015 - J 0.36
Benzo(a)anthracene	J 0.53	J 0.36	J 0.23	J 0.21	ND	0.7	<0.02 - J 1.1
Benzo(a)pyrene	J 0.58	J 0.41	J 0.24	J 0.25	ND	0.7	J 0.015 - J 1.1
Benzo(b)fluoranthene	J 0.53	J 0.40	J 0.24	J 0.22	ND	0.7	<0.04 - J 1.2
Benzo(e)pyrene	J 0.47	J 0.35	J 0.21	J 0.19	NA ⁵	NL ⁶	NA
Benzo(g,h,i)perylene	J 0.18	J 0.31	<0.21	J 0.14	ND	100	<0.018 - J 0.46
Benzo(k)fluoranthene	J 0.55	J 0.34	J 0.27	J 0.23	ND	7	<0.023 - 1.1
Chrysene	J 0.66	J 0.56	J 0.28	J 0.30	ND	7	<0.023 - 1
Dibenz(a,h)anthracene	J 0.066	<0.12	<0.23	<0.072	ND	0.7	<0.023 - <0.081
Fluoranthene	J 0.94	J 0.69	J 0.44	J 0.44	ND	600	<0.015 - J 2.8
Fluorene	J 0.094	<0.090	J 0.19	J 0.069	ND	400	J 0.028 - <0.10
Indeno(1,2,3-cd)pyrene	J 0.18	J 0.29	J 0.17	J 0.14	ND	0.7	<0.03 - J 0.31
Methylnaphthalene, 2-	J 0.025	ND	ND	ND	ND	0.7	<0.026 - <0.075

TABLE 3 (Cont.)
DECTABLE SVOCs IN SEDIMENT
(ppm)

	3A-SP	AR-US	BKB-BL	BKB-WR	BKB-HR-1, -2	MCP ¹	Clean NAE Projects ²
PAHs (Cont.)							
Methylphenanthrene, 1-	J 0.093	J 0.10	ND	J 0.047	NA	NL	NA
Naphthalene	J 0.036	ND	ND	ND	ND	4	<0.015 - B 0.10
Perylene	J 0.16	J 0.17	J 0.063	J 0.057	NA	NL	NA
Phenanthrene	J 0.67	J 0.38	J 0.30	J 0.30	ND	700	<0.019 - J 1.3
Pyrene	J 0.75	J 0.69	J 0.40	J 0.37	ND	500	<0.020 - J 2.2
Non-PAHs							
Benzoic Acid	J 0.074	J 0.37	J 1.1	J 0.27	ND	NL	<0.12 - <0.36
Biphenyl	J 0.018	ND	ND	ND	NA	1	NA
Carbazole	J 0.078	ND	ND	J 0.040	ND	NL	NA
Dibenzofuran	J 0.037	ND	ND	ND	ND	NL	<0.024 - <0.057
Nitrophenol, 4-	<0.020	ND	J 0.20	ND	ND	NL	<0.072 - <0.21
Trimethylnaphthalene, 2,3,5-	J 0.018	ND	ND	ND	NA	NL	NA

TABLE 3 (Cont.) DECTABLE SVOCs IN SEDIMENT (ppm)							
	3A-SP	AR-US	BKB-BL	BKB-WR	BKB-HR-1, -2	MCP ¹	Clean NAE Projects ²
Phthalate Esters							
bis(2-Ethylhexyl)phthalate	J 1.1	ND	J 0.28	J 0.12	ND	100	<0.066 - 3.4
Butylbenzylphthalate	J 0.94	J 0.065	ND	ND	ND	NL	<0.015 - J 0.34
Di-n-octyl phthalate	J 0.033	<0.13	<0.23	<0.074	ND	NL	<0.031 - <0.090
Diethylphthalate	J 0.022	J 0.073	J 0.13	J 0.057	ND	100	<0.053 - B 1.3

Notes: 1 - MCP Method 1 levels for S-1 soil and GW-1 groundwater.

2 - Range measured in NAE reservoir projects with clean sediments.

3 - Maximum concentrations are in bold.

4 - Not Detected

5 - Not Analyzed

6 - Not Listed

groundwater in a particular area can best be determined by a site-specific study. Otherwise, groundwater is classified by broad generalizations of potential aquifer yields. Mid to high yield aquifers are classified as GW-1.

Soils are classified based on accessibility, and frequency and intensity of use. Soils are characterized as "accessible," "potentially accessible," or "isolated" depending on their depth below the surface and the type of buildings at the site. Frequency of use is characterized as "high," "low," or "not present" depending on the expected numbers of people present at the site, and is determined separately for children and adults. Intensity of use is characterized as either "high" or "low" depending on the nature of site activities and their potential to disturb the soil. Table 4 contains the matrix used to determine soil categories.

The MCP includes tables for determining applicable soil standards for a large number of contaminants for a matrix of soil and groundwater types. It includes 3 methods for determining applicable soil standards. Method 1 is applicable for characterizing the risk of harm to health and the environment if the presence of oil and hazardous materials is limited to soil and groundwater. If it can be demonstrated that contaminants in the soil will not leach to groundwater and the only risk is through direct contact with the soil, then Method 2 soil standards may be used; Method 2 standards are equal to or higher than Method 1 standards. Method 3 may be used to characterize the risk to health and the environment where detailed information is available on the site, the hazardous material, and the exposure potential under all current and reasonably foreseeable site activities and uses. Site specific standards for soil and groundwater may be developed under Methods 2 and 3, but may not exceed the Upper Concentration Limits listed in the MCP.

Because this study involves a water supply system, SVOC levels were compared to Method 1 concentrations for an S-1 soil and a GW-1 groundwater. As shown in table 3, all SVOCs are below MCP Method 1 levels, and most are well below.

(2) NAE Projects. The Corps has completed a number of priority pollutant scans at its flood control reservoirs in New England, providing a useful database for comparison with other studies (USACE, 1998). Projects in relatively remote areas with relatively little development in their watersheds were judged to have "clean" sediments. Table 3 contains the ranges of contaminants measured in such clean sediments. Most of these compounds were found only in less than quantifiable concentrations, and many were only in less than detectable concentrations.

Comparison of detected levels of SVOCs at Cohasset, with the same compounds at NAE projects with clean sediments, shows similar levels. Only butylbenzylphthalate was reported at a level outside the range at these NAE projects, but it did not exceed it by much. Furthermore, the MCP does not address it because it is not particularly harmful, and it readily biodegrades.

MASSACHUSETTS CONTINGENCY PLAN

SOIL CATEGORY SELECTION MATRIX - HUMAN EXPOSURE POTENTIAL

* - Category S-1 also applies to any accessible soil where the current or reasonably foreseeable use of the soil is for growing fruits and vegetable for human consumption.

(3) Other Compounds. There are 5 SVOCs found in detectable concentrations in this Cohasset study which are not addressed by the MCP and which have not been measured at NAE projects. These are benzo(e)pyrene, carbazole, 1-methylnaphthalene, perylene, and 2,3,5-trimethylnaphthalene. All are products of incomplete combustion, and all but carbazole are PAHs. Lacking reference samples or MCP levels, definitive conclusions cannot be made. However, as these compounds are all within the range of concentrations of the other SVOCs, which appear to be within background concentrations, it is likely they are also.

(4) Station Comparisons. As shown in table 3, station 3A-SP (a stream between Route 3A and Sanctuary Pond) had the highest overall concentration of SVOCs, while the 2 Brass Kettle Brook stations (BKB-BL and BKB-WR) had the lowest. This may indicate slightly higher contaminant levels near the Cohasset Heights, Ltd. landfill, but more likely indicates the natural variation inherent in sampling sediments.

c. Sediment Data - Metals. Of the 8 metals tested, detectable concentrations were found of arsenic, barium, chromium, mercury, lead, and selenium, but none were in concentrations high enough to be a real concern. Table 5 contains a summary of this data. Also included in table 5 are: the MCP Method 1 levels for these metals in an S-1 soil and GW-1 groundwater, the range of commonly reported average levels of these metals in the earth's crustal soils, the range of these metals found at Corps reservoir projects in New England with clean sediments, and the Massachusetts Department of Environmental Protection (MADEP) background levels.

MADEP background soil concentrations are derived from a database of background samples taken from rural and suburban locations, and are contained in *Guidance for Disposal Site Risk Characterization*, MADEP, July 1995. They have been judged by the MADEP staff to be sufficiently representative of Massachusetts's non-urban locations that use of these values, as screening criteria, should be protective of public health and the environment. These values represent the 90th percentile values from the collected data set; consequently, a sample could be below this level and still represent an elevated condition. On the other hand, a metal measurement could exceed this and still be entirely due to natural background conditions.

All measured metals were below MCP levels, arsenic and chromium were below MADEP background levels, and all but lead at station BKB-BL were within the range found at Corps projects with clean sediments. While some of these metals levels may indicate an increase in background levels, they are not high enough to indicate a real concern.

d. Sediment Data - Lead. This was the only metal that was elevated above all reference background concentrations. The highest lead level was 180 ppm at station BKB-BL. This is almost twice the maximum reported for NAE projects with clean

TABLE 5
DETECTABLE METALS IN SEDIMENT
(ppm)

	3A-SP	AR-US	BKB-BL	BKB-WR	BKB-HR-1	BKB-HR-2	MCP ¹	Earth's Crust ²	Clean NAE Projects ³	MADEP Background ⁴
Arsenic	1.4	<7.2	<7.8	3.7⁵	<1.8	<0.80	30	1.81 - 6.0	0.6 - 28	17
Barium	<27	<144	<157	62	100	50	1,000	400	36 - 110	45
Chromium	5.2	16	10	21	5.7	2.4	1,000	5 - 3,000	2.6 - 52	29
Lead	56	89	180	99	94	42	300	10 - 16	2 - 99	99
Mercury	<0.14	<0.74	<0.85	0.52	<2.3	<1.0	20	0.03 - 0.5	<0.03 - 0.52	0.3
Selenium	<1.3	<7.2	<7.8	3.2	3.9	1.6	400	0.03 - 0.09	<0.6 - 5	0.5

Notes: 1 - MCP Method 1 levels for S-1 soil and GW-1 groundwater.

2 - Range of commonly reported average levels in the earth's crustal soils.

3 - Range measured in NAE reservoir projects with clean sediments.

4 - MADEP background soil concentrations from Guidance for Disposal Site Risk Characterization.

5 - Maximum concentrations are in bold.

sediments and MADEP background levels; however, it is well below the MCP Method 1 level for an S-1 soil and GW-1 groundwater. This finding, while not high enough to be a definite concern, does warrant further discussion.

Lead has no beneficial or desirable nutritional effects, as it is a toxic metal that accumulates in the tissues of man and other animals. In addition to their natural occurrence, lead and its compounds may enter and contaminate the environment through mining, smelting, processing, and usage especially through automobile exhaust before the elimination of lead additives to gasoline. Lead enters the aquatic environment through precipitation, lead dust fallout, erosion and leaching of soil, municipal and industrial waste discharges, and runoff of fallout deposits from streets and other surfaces (EPA, 1976).

Certain lead salts, such as acetate and chloride, are readily soluble, but because the carbonate and hydroxide are insoluble and the sulfate is only sparingly soluble, lead will not remain long in natural waters (McKee and Wolf).

Naturally occurring levels of lead in the earth's crustal soils have been variously reported as 12.5 (Aherns, 1975), 16 (Lisk, 1980), a mean of 10 with a range of 2 to 200 ppm (Allaway, 1968), and a mean of 15 with a range of 1 to 200 ppm (Swaine, 1955). A study of the total lead content of soils in this country found an average of 16 ppm and a range of 10 to 700 ppm (Lisk, 1980). Kesler-Arnold and O'Hearn (1990) found background levels in Lower Michigan soils had a range from less than 0.5 to 140 ppm with a mean of 10.3 ppm. Krauskopf reported the average abundance of lead in shale was 20 ppm. Miller and McFee (1983) examined surficial soil samples from 5 areas of industrialized north-western Indiana; lead levels ranged from 755 in urban soils to 163 ppm in rural soils. At a depth of 30 to 36 centimeters, all soil samples had 0.2 to 0.9 ppm lead. Friedland, et al (1992) examined lead in forest floor samples from New England and New York; he found a mean level of 146 ppm in 1980 and 121 ppm in 1990.

A finding of 180 ppm of lead in New England soils indicates an increase over background conditions. While it is more likely an anomaly than an indication of a source of contamination, it would be prudent to take additional metals samples in the area.

e. Sediment Data - Pesticides and PCBs. Although not called for in the contract, Alpha Analytical Laboratories analyzed pesticides and PCBs in the two samples from Brass Kettle Brook at Howes Road (BKB-HR-1 and BKB-HR-2). No detectable concentrations were found. Method detection limits were 0.2 to 1.8 ppm for pesticides, and 1 to 2.3 ppm for PCBs. These detection limits are acceptable for confirming the absence of contamination, but are too high to measure expected levels of these contaminants. Experience at NAE projects has shown that pesticide levels in relatively clean sediments are generally less than 0.01 ppm, and PCB levels are less than 1 ppm. For this study, it was sufficient to confirm the absence of contamination.

5. CONCLUSIONS

a. Hingham Annex and Wompatuck State Park. Results from this study did not detect any evidence of contamination coming from the Hingham Annex site or Wompatuck State Park. SVOCs and metals were low and within natural background concentrations in Brass Kettle Brook and in the Aaron River at Union Street. These are the stations that would pick up contamination from if it were coming from these former Defense Department sites.

The absence of contamination from the Hingham Annex is in agreement with findings in the most recent and comprehensive study of the site: the *Revised Draft Phase II - Comprehensive Site Assessment, Hingham Annex*, prepared by ABB Environmental Services, Inc., in May 1997. Conclusions of this study include, "The results of the evaluation of exposure to Brass Kettle drainage basin surface water, which are based on conservative assumptions (i.e., that site-related OHM [Oil and/or Hazardous Material] could migrate undiluted over 2 miles to Lily Pond), confirm the conclusions of the *Preliminary Draft Environmental Assessment Report* (ENSR, 1997) that, based on the results of surface water sampling, there is no impact to off-site drinking water sources via the surface water migration pathway." This is also in agreement with a March 1998 Site Investigation Closure memorandum prepared by the Agency for Toxic Substances and Disease Registry (EPA 1998) that concludes that the, "Burning Grounds at the Wompatuck State Park and the Mount Blue Spring present no apparent health hazard."

b. Cohasset Heights Ltd. Landfill. Station 3A-SP and the Brass Kettle Brook stations, receive runoff and groundwater seepage from the area around the Cohasset Heights Ltd. landfill. Data collected in this study at these stations did not detect any real signs of contamination. VOCs and all metals but barium were less than detectable in water, and barium was in harmless concentration. Chloride was higher at station 3A-SP than at other stations, but not enough to indicate a problem. Conductivity was also higher at this station, but this is due to the observed higher chloride level. Sediments at station 3A-SP had among the lowest metals levels in this study. While the overall highest SVOC levels were at station 3A-SP, they were still low and within the range observed at NAE projects with clean sediments.

A pattern of decreasing lead levels from stations BKB-BL, to BKB-WR, to BKB-HR-1, and BKB-HR-2 and a maximum of 180 ppm at BKB-BL indicate a possible upstream source. Further investigation would be required to determine whether this is an anomaly or an indication of a real problem.

c. Other Sites. Water samples collected at stations 3A-SP, PB, and AR-DS to check for septic system problems and overland runoff problems, did not detect evidence of definite problems. The fecal coliform level of 290 per 100 ml at Peppermint Brook is high for a dry weather flow condition, but coliform counts increase after rainstorms. Similarly, the 0.37 ppm nitrate at this station is not necessarily a concern. Additional

sampling is required to determine more conclusively if there are problems in this area.

6. RECOMMENDED SAMPLING

It is impossible to prove that contamination is not coming from a site. No matter how many times test results come back negative, it is always possible that samples were taken in the wrong place, or at the wrong time, or for whatever other reason that the contamination was missed. This was hardly a comprehensive study; however, based on results of this and previous studies, it is reasonable to assume that metals and organic chemicals contamination is not coming from the Hingham Annex. The most likely contamination problems in this watershed are the most common ones: coliform and algal nutrients from problem septic systems and overland runoff.

Areas of possible problems identified in this study are lead levels in Brass Kettle Brook and fecal coliforms and nitrate in Peppermint Brook. To resolve the lead issue, sediment from the Brass Kettle Brook stations along with another station 100 yards upstream from BKB-BL should be analyzed for lead. If these again show elevated levels of lead, additional samples should be taken from stations continuing upstream. Consideration should then be given to including analyses for other metals including chromium, cadmium, zinc, copper, and iron.

More information is needed on variations in coliform counts during storms to resolve concerns about the 290 fecal coliform count at Peppermint Brook. Sampling is needed at different points during the storm hydrograph, which from a practical point of view may require the use of automatic sampling machines set to start sampling when streamflow rises to a certain level. The optimum sequence depends on the unique characteristics of a watershed which can only be determined by trial and error, but it is likely that 12 samples taken hourly from a stream after the flow has risen 1 inch during a rainstorm, will give good results. As a minimum, samples should be analyzed for fecal coliform and nitrates. Additional parameters for consideration include total phosphorus, ammonia, nitrite, and chloride. Sampling one storm in this manner might resolve concerns, but it is more likely that 2 or 3 storms will have to be sampled before satisfactory conclusions can be drawn.

High coliform counts during rainstorms may be a problem, but high counts during dry weather are definitely a concern. A program to watch for such problems should include as a minimum, quarterly sampling with an extra set in the spring for a total of five samplings per year. Samples should be collected at stations PB, AR-DS, and 3A-SP and analyzed for fecal coliform. Other locations that Cohasset has information on or concerns about should be added to this list. In addition, a storm at a minimum of one station a year should be analyzed by collecting hourly samples for at least 12 hours from the start of a noticeable increase in flow in the stream.

Nitrogen and phosphorus are concerns because they affect the trophic condition of Lily Pond. Measuring these nutrients along with the coliform sampling described above

would help watch for changes in the watershed. However, it would also be important to monitor the trophic status of Lily Pond directly, especially if there is other evidence of cultural eutrophication. Sampling should be performed at least twice in the spring and once during midsummer. Parameters to be measured include nitrate, ammonia, total phosphorus, algal cell counts, and Secchi disc depth. If a single algal species is dominating the counts, it should be noted and identified. If aquatic macrophytes are a concern, the area of plants should be mapped, and the dominant species noted and identified. Finally, at least once during the summer, temperature, dissolved oxygen, and pH profiles should be measured at one meter intervals from the surface to the deepest part of Lily Pond.

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